An Evaluation of the Individuality of the Two Types of Remington 870 Extractors – Metal Injection Molded vs. Milled

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ABSTRACT

Remington 870 shotguns possess different types of extractors depending on whether it is a commercial or law enforcement variant. The commercial 870 shotguns are equipped with a metal injection molded extractor whereas the law enforcement versions have a milled extractor. Six extractors of each type were examined and compared to determine if there was any carryover of class or individual markings within a type or between the two types. Although some similarities existed between each extractor within each type, each extractor was still able to be differentiated from one another and the extractor marks were all able to be identified back to their corresponding extractor.

Introduction

The Remington Arms Company has been producing slide action shotguns since 1907 with the introduction of the Model 10. This model was Remington's most popular shotgun until the development of the Model 870 in 1950. Today, over 64 years later, the Remington 870 is still one of the most popular shotguns, not only in the commercial market, but also in the law enforcement market, with over 10 million produced. Although the platform of the 870 is fairly similar between the two different versions, there are still some minor differences between them. The 870 Police shotgun marketed to the law enforcement community contains enhanced features that the commercially marketed Model 870 does not. Some of these features include cosmetic options such as a higher quality finish to the receiver, barrel, and stock, a shorter fore-end, and police options such as sling swivel studs, a magazine extension tube, and various sight options. The 870 Police shotgun also has other mechanical features to increase its longevity such as heavier shell latches, sear springs, and carrier springs, as well as a longer magazine spring. In addition, to increase the strength, parts are machined from metal rather than manufactured by a process called metal injection molding. These parts include the trigger guard and small parts such as the extractor and ejector. [1-5]

Extractor Manufacturing

The machined metal extractors and ejectors equipped in the law enforcement Model 870 Police are milled from solid steel into the desired shape. In the production of these milled extractors, there are no CNC machines or automated operations; everything is performed manually by an experienced operator. The manufacturing process of these milled extractors begins with a solid piece of rectangular steel known as an extractor blank. The extractor blank is first ground to its general size. Then utilizing a manual milling machine, the right side of the extractor blank is milled to shape. The extractor is then manually de-burred with a file. The same milling and de-burring process is subsequently performed to the left side of the extractor. Three extractors at a time are then broached on the hook side to generate the shape. A hollow mill drill press is then used to cut the outer dimensions of the extractor. The extractors then go through another round of manual de-burring with a file. All of the extractors are then stamped with the letter "L" for identification purposes and chamfered behind the hook. The extractors then undergo finishing processes that include polishing all sides on a 150 grit polishing wheel, a wash, a microcarb hardening, an oil quench, and then heat treatment in a furnace at 350 degrees Fahrenheit. The parts are then inspected for hardness, degreased, bead blasted, dipped in oil for rust prevention, and then sent to storage or assembly. [13]

The commercially marketed 870 shotgun, on the other hand, is equipped with a metal injection molded (MIM) extractor and ejector. MIM manufacturing offers several advantages to the company including cost effectiveness, a shorter production time, and a more automated process. Remington has been producing MIM parts for their firearms since 1980. Furthermore, they have been commercially producing MIM parts for other companies since 1986. The MIM facility at the Remington plant in Ilion, NY produces MIM triggers, sears, extractors, ejectors, trigger guards, and sights for various Remington firearms. [6,7]

Remington's MIM manufacturing process involves mixing the components, molding, debinding, sintering, and then any other secondary operations as desired (**Figure 1**). The components required for this process are finely powdered metals or alloys and a thermoplastic binder, which are both certified from the supplier. These components are first added to an extruder in a mixture of 60% metal alloy and 40% binder by volume.

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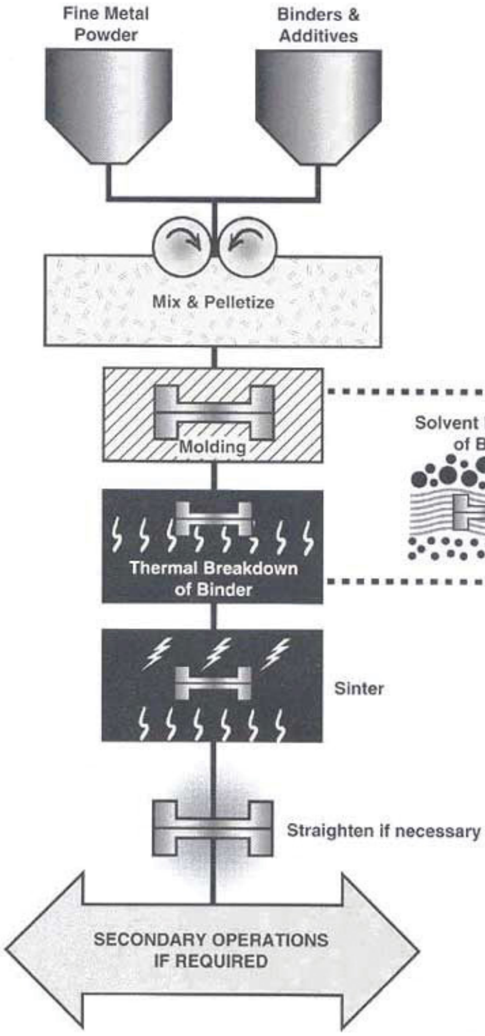

Figure 1: Overview of Remington's MIM process for various parts, including extractors for the 870 [10]

The two components are heated and mixed together and then extruded into rods, forming feedstock. Once cooled, the feedstock is cut into pellets and either directly used or stored for future use. Each lot of pelletized feedstock is tested to check the density and melt flow index before being used. [7-9]

The Remington MIM facility utilizes injection molding machines equipped with two mold halves that are mirror images of one another. These molds are manufactured out of premium tool steel that is outsourced from other vendors. Each mold consists of 2-8 cavities that are cut into the desired shape of the final product using electro-discharge machining (EDM) and are then polished. The Model 870 MIM extractors are all made from one mold with four cavities using stainless steel metal powder. According to Hunsinger's research, "Remington MIM molds have an average life of 250,000 injections per cavity" before they need to be replaced [8].

Figure 2: Remington triggers before and after debinding/sintering, displaying 15-20% shrinkage

Each cavity has a gate or opening in which the material flows through to fill the cavity. The molding process begins with a specific volume of pelletized feedstock being transferred to a hopper. The hopper dispenses the feedstock pellets into a heated tube in the injection molding machine. This tube heats up the feedstock gradually to a temperature of 330-360°F to ensure that it is completely melted. The feedstock flows under pressure from the tube, to the sprue, to the runner, to the gates, and into each cavity in the closed mold. The mold is kept at a temperature between 80-120°F, so that once the cavity is filled with feedstock, it immediately begins to cool. The cooling time of the cycle is approximately 15-20 seconds. Once the parts are cooled, they are ejected from the cavities by two ejector pins per cavity. The entire molding cycle lasts about 35-45 seconds from start to finish. These newly molded parts, or "green" parts, are 15-20% larger than the final product. The green parts are then placed on porous ceramic plates (**Figure 2**).

From this process the parts exhibit mold seams or parting marks where the two halves of the mold came together, ejector pin marks, a gate mark where the gate was removed, and mold cavity identification marks indicating the specific cavity the part was molded in (1-4) (**Figures 3 and 4**) [7-11].

At Remington, the debinding and sintering steps are combined into one. The plastic binder that was utilized to help the metal flow into the mold cavities needs to be removed in order to increase the density and strength of the part. The "green" parts that are on the ceramic plates are placed on a conveyor belt that carries them into a vacuum debinding/sintering furnace. This furnace has multiple programmed feeding steps that vary in temperature and pressure. The parts are gradually heated up to a temperature between 2450-2500°F and are then kept at that temperature for about an hour. Thermal debinding at a lower temperature than the melting point of the metal gradually removes most of the binder from the part, leaving pores in the structure. The sintering temperature is still below the melting temperature of the metal, but it allows the metal to become soft. The soft metal then fills in the pores left behind from the binder. As the metal molecules move around to fill in the empty space, the part shrinks about 15-20% in a controlled manner (**Figure 2**). The debinding/sintering step achieves a part that is about 97-98% dense. Once the parts exit the furnace, they are allowed to cool and then undergo finishing operations. Once cooled, 870 extractors are surface cleaned by blasting aluminum oxide media at the surface. The extractors then undergo a secondary heat treatment process that includes steps of solution annealing, a cryogenic quench, and then an aging treatment at 900°F. The MIM 870 extractors are then inspected after heat treatment, glass bead blasted, cleaned, and then sent to the floor stock for assembly in the shotguns. [7-11]

Previous Research

There have been several studies that examine the reproducibility and individuality of tool working surfaces including many consecutively manufactured tools, barrels, breech faces, and extractors. In particular, there have been two studies that address extractors in the field of Firearms Identification. The first of these articles was published in 2009 by Dennis Lyons where he examined ten consecutively manufactured milled extractors from Caspian Arms Ltd. for a Colt Model 1911 pistol. Lyons fired a pair of cartridges in the pistol for each of the ten extractors and evaluated each microscopically to determine the quality of the extractor markings. Lyons was able to identify each cartridge case back to one another only using the extractor marks. He then generated test sets utilizing the ten extractors, which were sent out to qualified firearms examiners throughout the country for analysis. Out of the 22 test results returned, “a total of 259 correct answers out of a possible 262 were produced,” giving the test an error rate of 1.2%. One of these examiners, Ronald Nichols, evaluated the surfaces of these extractors and their potential for subclass characteristics in addition to his examination of the cartridge cases for Lyons. Both Lyons and Nichols’ research demonstrated that consecutively manufactured milled extractors were able to be differentiated from one another even with the presence of subclass characteristics. [12,14]

The most recently published study addressing extractor marks was authored by Michelle Hunsinger in 2013. Hunsinger’s research focused on the metal injection molded strikers and extractors equipped in Smith & Wesson M&P pistols. Five MIM extractors and strikers were examined microscopically and then 300 cartridge cases were fired for each pair.

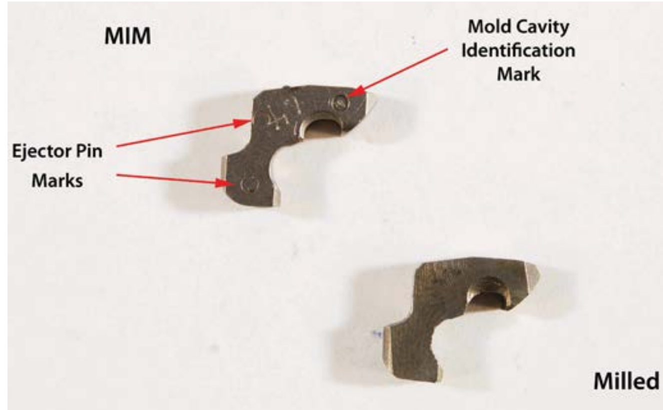

Figure 3: Markings on the MIM and milled extractors, view from top

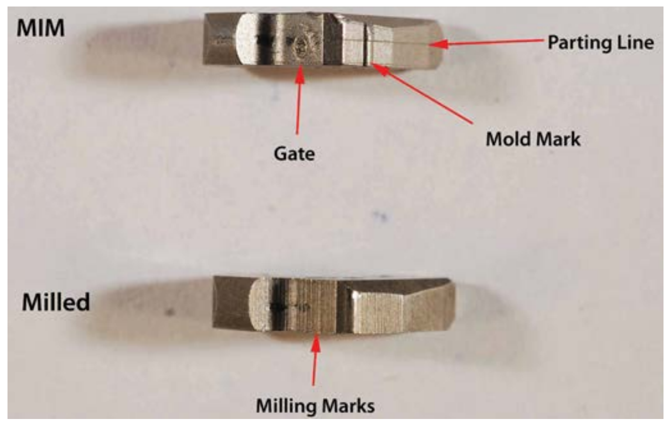

Figure 4: Markings on the MIM and milled extractors, view from top

Hunsinger concluded that there was subclass carry-over from one extractor to the next. This carry-over was observed not only in the extractor mark but also on the granular surface of the extractor itself. Hunsinger concluded that “MIM itself has a potential for agreement of characteristics within toolmarks made by separate tools from the same mold.” The author also suggested that further studies into the possibility of subclass characteristics with MIM extractors be performed and that manual cycling extractor marks be examined in addition to the fired extractor marks. [8]

This current study was initiated due to the recent popularity of MIM parts in the firearms community and the lack of research related to extractor marks. The Remington 870 was chosen because these shotguns are equipped with both types of extractors, milled and MIM, allowing a complete evaluation of their individuality without the addition of other variables.

From a thorough microscopic evaluation of the extractor markings produced on fired and cycled shotshells from a

Remington 870 shotgun, the objectives of this study include: 1.) to determine whether or not the Remington 870 MIM extractors from the same mold cavity or the same mold can be distinguished from one another; 2.) to establish if milled extractors can be differentiated from one another; 3.) to determine if there are any distinct differences between the markings produced by the two different types of extractors.

Materials And Methods

Sample Preparation

Six metal injection molded extractors and six milled extractors for the Remington 870 were received from the Remington Arms manufacturing plant in Ilion, NY. Although the milled extractors were consecutively manufactured, they were not labeled as to their order. The MIM extractors all contained the cavity identification number so it was clear which cavity produced each extractor. There were a total of three extractors from cavity #1 and one extractor each from cavity #2, #3, and #4. Since Remington 870 MIM extractors are all made utilizing one mold, a representative sample of the mold cavities was obtained. This sample allows a comparison within a cavity to be completed as well as a comparison from one cavity to the next. Each extractor was scribed with a unique number to identify them. The MIM extractors were labeled with a 1 to designate that it was a MIM part, followed by their corresponding cavity number. The extractors from cavity #1 were labeled 1.1A, 1.1B, and 1.1C, the extractor from cavity #2 was 1.2, from cavity #3 was 1.3, and from cavity #4 was 1.4. The milled extractors were labeled with a 2 to designate they were milled extractors followed by a number, for example 2.1, 2.2…2.6.

An extractor from each type was utilized to perform initial testing to determine which type of ammunition exhibited the best extractor marks for use during the actual production of test fires. A representative sample of shotshells including birdshot, buckshot, and slug shotshells from various manufacturers were chosen. All extractor marks were evaluated on the comparison microscope and the brand that produced the most distinctive extractor marks for both types of extractors was Federal Power-Shok 12ga 2-¾” Buckshot – 4 Buck.

It was of interest to determine if there was a difference in extractor marks on shotshells that had been cycled through a shotgun unfired versus fired. Shotshells were cycled through the mechanism of the firearm, five unfired and five fired, for each of the extractors. Shotshells were then labeled with a “C” (cycling-unfired) or “F” (fired), along with what extractor they were from.

Generating Test Samples

The Remington 870 shotgun selected for this study was field stripped and the extractor was replaced with the 1.1A extractor. Shotshells were cycled through the action by manually inserting a shotshell in through the ejection port and onto the carrier. The action was then closed and opened to extract the shotshell from the chamber. All five shotshells were manually cycled through the firearm and collected. The shotgun was then placed into a Caldwell Lead Sled and a shotshell was manually inserted into the ejection port onto the carrier, the action was closed, and the shotgun was fired. This process of cycling five and firing five shotshells was repeated with each of the MIM and milled extractors.

Extractor Mark Comparisons

The first step in the microscopic examination was to compare all of the shotshells to one another that were fired or cycled with the same extractor. All of the cycled and fired shotshells were examined individually and then compared to each other to evaluate the reproducibility of the extractor marks. The quality of these extractor marks in both instances was also noted for future reference. This allowed for similar markings to be noted so that the identifiable patterns of marks produced by each extractor could be determined.

Once all of the 120 intra-comparisons were completed, fired shotshells for MIM extractors 1.1A, 1.1B, and 1.1C were inter-compared to determine if there was any carryover of markings within extractors made from the same mold cavity. Next, cycled shotshells for all of the MIM extractors were inter-compared to determine if there was any carryover from cavity to cavity within the same mold. Shotshells from milled extractors 2.1 through 2.6 were also inter-compared to each other for both the cycled and fired shotshells to determine if there was any carryover. In addition, one shotshell fired and one shotshell cycled from the same milled extractor were compared to each other to establish if there were any differences in the extractor marks between manually cycling and firing the shotshells. The cycled shotshells from the MIM and milled extractors were also compared to one another to determine if there were any distinct differences that denote one or the other. The surfaces of the extractors themselves were also compared for both the MIM and milled extractors to evaluate the surface finishes.

Shoulder vs. Lead Sled Fired Shotshells

Due to the quality of the extractor marks on the fired shotshells, it was hypothesized that firing the shotgun from the Lead Sled rather than firing from the shoulder was affecting the extractor mark. To test this theory the same firearm was field stripped and extractor 1.1A was re-installed. Two shotshells of the same brand previously used were fired from the shoulder. Two shotshells were also test fired from the shoulder utilizing extractor 2.1 so that both MIM and milled extractor marks could be evaluated. These shotshells for each extractor were then compared to one another to establish reproducibility. The shotshells fired from the shoulder were then compared to the shotshells fired from the Lead Sled to determine if there were any differences for each extractor.

Blind Comparison

The last part of this study examined the individuality of each of the extractor marks. One shotshell was manually cycled through the same Remington 870 for each of the MIM and milled extractors. Each shotshell was placed in a labeled plastic bag identifying which extractor the shotshell was cycled from; no markings were placed on the shotshell. The shotshells were then given to a technician to randomly assign a letter to each shotshell. The shotshells were removed from the bags at random and marked with a letter of A through L. The technician then placed the identifying letter next to the extractors on a chart so the correct answers were known. The lettered shotshells were then compared to the known cycled shotshells from each extractor. After all of the comparisons were completed, the results were compared to the chart identifying the actual answers.

Results

Initial Examination of Extractors and Corresponding Marks

The milled and MIM extractors were observed under the comparison microscope to determine any surface differences between the two. The MIM extractor surfaces had a pitted appearance that was granular in nature while the milled extractor had an appearance that signifies that some of the surfaces were ground to specifications during manufacture. The hook and inside surface of the milled extractor had a “scaly” appearance that was hypothesized to be from heat treating without finishing processes (**Figure 5**).

Each of the shotshells exhibited extractor marks on the head and under the rim of the shotshell. Some striations within the mark were angled in reference to the rim while others were perpendicular to the rim (**Figure 6**). The reason for this change of angle was suspected to be from the rotation of the shotshell as it enters the chamber and as it is extracted and ejected out of the chamber. The milled extractor marks, overall, exhibited more distinctive striations with greater depth variations than the MIM extractor marks.

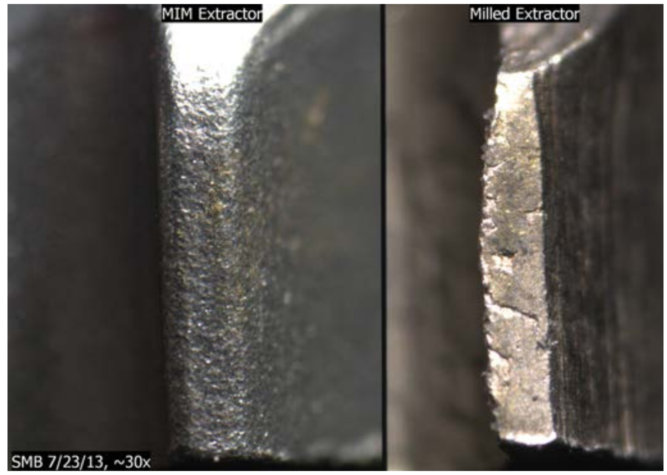

Figure 5: Surface of each extractor hook (~30x)

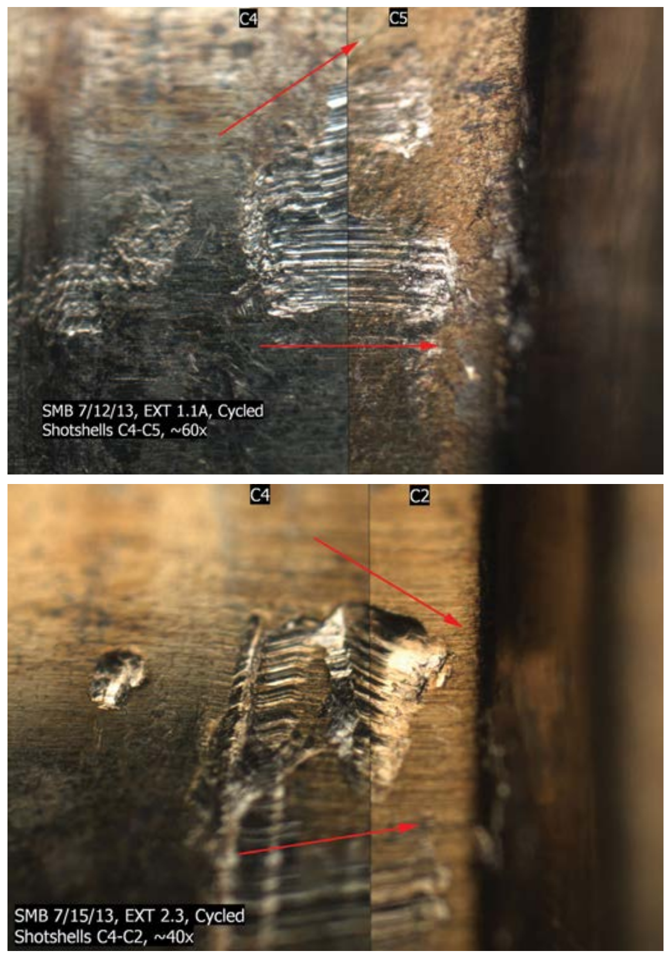

Figure 6: Comparison of marks from extractor 1.1A (MIM, top) and 2.3 (milled, bottom), depicting the change in angle of the striations in the extractor mark

Extractor Mark Comparison

The fired shotshells for both the MIM and milled extractors seemed to have most of their detail under the rim of the shotshell. Shotshells fired with extractors 1.1A, 1.1B, and 1.1C had some striations in the extractor mark that were able to be compared but none of the MIM extractors left sufficient detail on the fired shotshells. The fired shotshells from the milled extractors, however, did leave sufficient detail for a comparison examination. All of the extractor marks on the fired shotshells were able to be identified back to the milled extractor that generated it except for extractor 2.5, which was inconclusive, due to a lack of detail on more than one shotshell case (**Figure 7**).

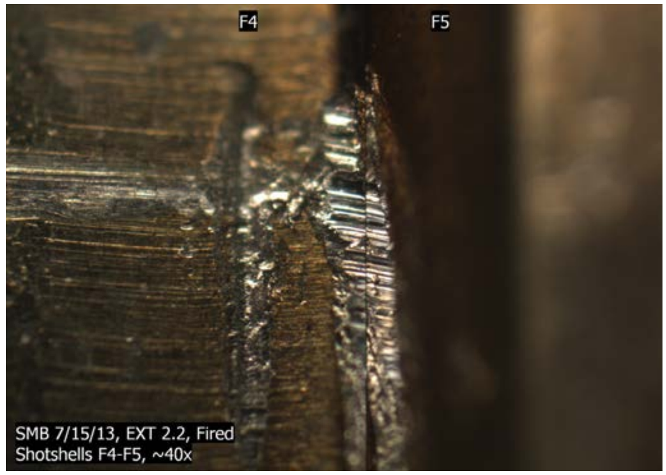

Figure 7: Comparison of shotshells F4 and F5 w/ marks from extractor 2.2 (~40x)

The cycled shotshells for both the MIM and milled extractors, on the other hand, showed significantly more detail in the extractor marks than the fired shotshells. The extractor marks for the cycled shotshells were more apparent on the head of the shotshell rather than under the rim. All but one of the extractor marks on the cycled shotshells from both the MIM and milled extractors were able to be identified back to its respective extractor (**Figures 8 and 9**).

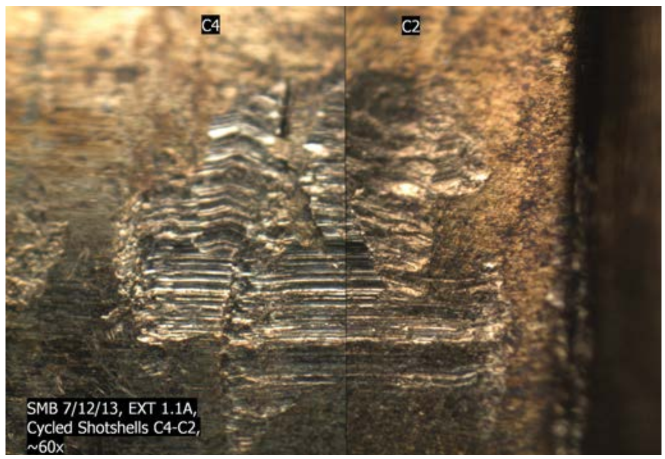

Figure 8: Comparison of shotshells C4 and C2 w/ cycled marks from extractor 1.1A (~60x)

The cycled extractor mark from extractor 1.2 produced an inconclusive result due to little detail in any of the shotshells. The cycled extractor marks from the milled extractors were more pronounced with more defined striations than the cycled extractor marks from the MIM extractors (**Figures 8 and 9**). All five of both the fired and cycled shotshells for each extractor exhibited similar extractor marks from shotshell to shotshell.

A representative shotshell for each extractor was chosen based on the quality of the extractor marks for both the fired and cycled shotshells. Due to the fact that only fired shotshells from extractors 1.1A, 1.1B, and 1.1C exhibited sufficient detail for a comparison, only these three were inter-compared. These extractors, made from the same mold cavity, were not able to be differentiated due to the lack of striations in the fired shotshells. Therefore, the carryover of markings in these fired MIM extractor marks could not be completely evaluated.

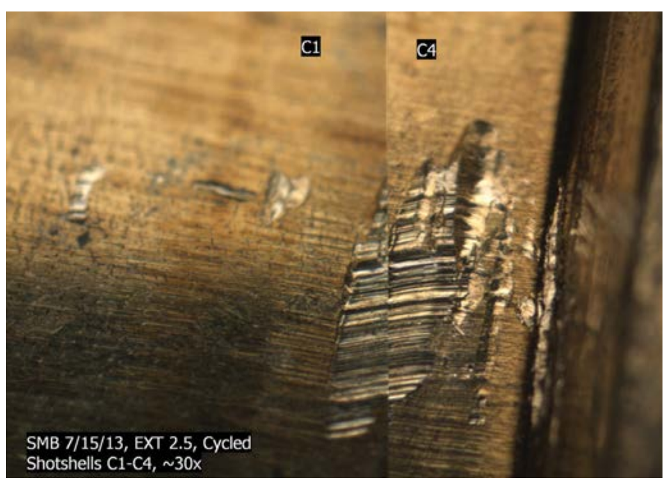

Figure 9: Shotshells C1 and C4 w/ cycled marks from extractor 2.5 (~30x)

One cycled shotshell from each of the MIM extractors were compared to each other and some carryover was observed. Some agreement of striations existed between the extractor marks 1.1A, 1.1B, 1.1C, and 1.2. The most agreement observed between the cycled MIM extractors can be seen in **Figure 10** between extractors 1.1A and 1.1C. However, the degree of agreement observed between these four extractor marks was not the same quality and quantity of agreement noted when comparing extractor marks produced from the same extractor.

The extractor marks from extractors 1.3 and 1.4 had some random agreement when compared to the other five extractor marks but they were still able to be differentiated from one another (**Figure 11**). Therefore, mold cavities 3 and 4 were able to be differentiated from the other 2 mold cavities.

One shotshell fired from each one of the milled extractors were also compared to one another. The fired shotshells from extractors 2.1 through 2.6 were all able to be differentiated. Some random agreement did exist in 5 out of the 15 comparisons with the most agreement seen between the fired shotshells from milled extractors 2.4 and 2.6 (**Figure 12**). However, this agreement was only observed on the right side of the extractor mark near the rim. The random agreement observed between these fired shotshells was not consistent with the known match comparisons.

The cycled shotshells from the milled extractors were also inter-compared to evaluate the individuality of the milled extractors. There was some agreement observed in the gross striations, however, disagreement existed in the finer details of the extractor marks in many of the cycled shotshells from the milled extractors. In the 7 of 15 comparisons that exhibited some agreement, most of the agreement was in one area and not consistent throughout the entire extractor mark. In addition, the spatial relationship and width of the striations were not similar between these extractor marks. Furthermore, the agreement observed was not consistent with the agreement in the comparisons of shotshells cycled from the same extractor. The most agreement observed in the extractor marks was between cycled shotshells from extractors 2.3 and 2.6 (**Figure 13**). In this comparison, the extractor marks

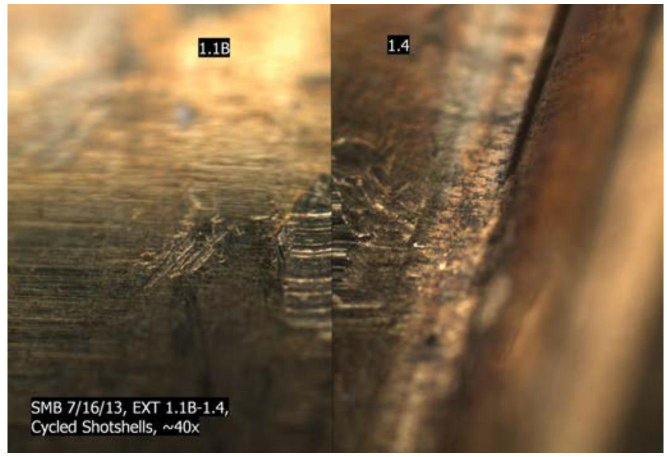

Figure 11: Disagreement observed between marks from extractors 1.1B and 1.4 (~40x)

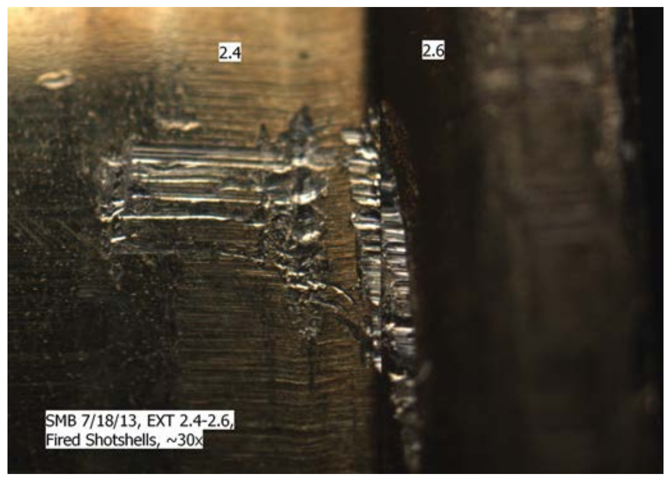

Figure 12: Random agreement between fired marks from extractors 2.4 and 2.6 (~30x)

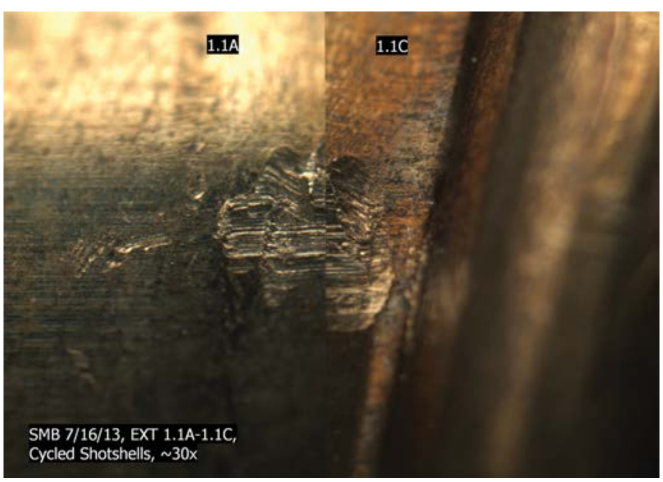

Figure 10: Most agreement observed between cycled marks from extractors 1.1A and 1.1C (~30x)

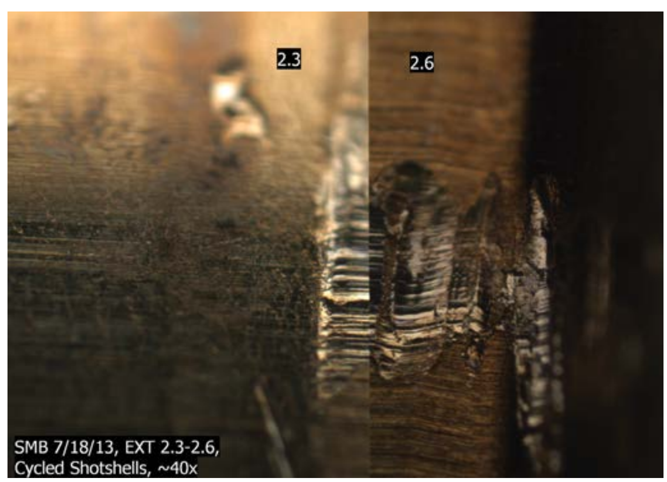

Figure 13: Most agreement observed between cycled marks from extractors 2.3 and 2.6 (~40x)

exhibited agreement at the bottom of the mark but when in phase at the bottom, the top did not display any agreement.

To evaluate if there were any differences between cycled and fired extractor marks, the cycled and fired shotshells from the same extractors were compared. Since the MIM extractors did not exhibit enough detail in all of the fired shotshells for a comparison examination, only the milled extractors were utilized. The striations on the fired shotshells were not as distinct or abundant as on the cycled. In addition, as stated previously, the fired shotshells exhibited extractor marks with striations on the head towards the rim and under the rim, while the cycled shotshells had extractor marks with striations on the head more towards the body. In every comparison of the milled extractor marks, some agreement could be observed between the marks (**Figure 14**). The striations that were present in each of the shotshells could be oriented, but due to an overall lack of striations and their location on the fired shotshells, the agreement was insufficient for an identification.

A lack of detail in the extractor marks on the fired shotshells was observed. It was hypothesized that this may be due to firing the shotgun in the Lead Sled versus firing from the shoulder. The comparison of the "fired from the Lead Sled" shotshells and the "fired from the shoulder" shotshells revealed a significant difference in the quality of the extractor marks. For the MIM 1.1A extractor, the quality of the extractor marks for the shoulder fired shotshell was considerably improved when compared to the Lead Sled fired shotshells (**Figure 15**).

The Lead Sled and shoulder fired shotshells for extractor 1.1A were able to be identified to one another as well as to the shotshell cycled using 1.1A (**Figure**s **16 and 17**).

Figure 15: Quality of marks from extractor 1.1A, fired from shoulder and lead sled (~30x)

Figure 16: Agreement of marks from extractor 1.1A, fired from shoulder and lead sled (~40x)

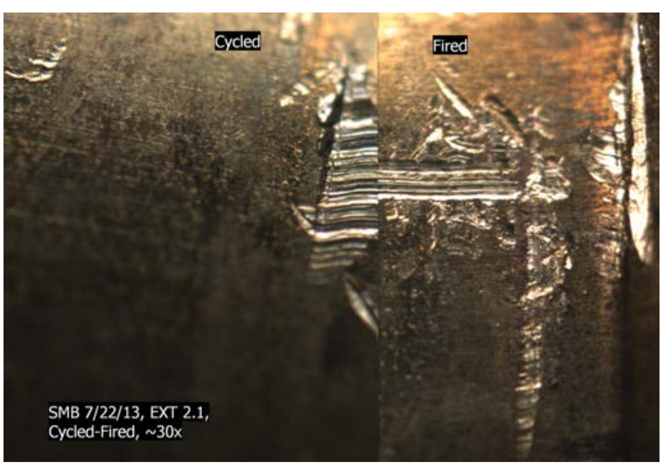

Figure 14: Agreement observed between cycled/ fired marks from extractor 2.1 (~30x)

Figure 17: Agreement between marks from extractor 1.1A cycled/fired from the shoulder (~40x)

The extractor mark on the shotshells fired from the shoulder with the milled extractor 2.1, on the other hand, decreased in quality. The shoulder fired shotshell case lacked striations for a comparison examination. Unlike the MIM extractor 1.1A, the Lead Sled fired shotshell from extractor 2.1 exhibited more detail and striations than the shoulder fired shotshells (**Figure 18**).

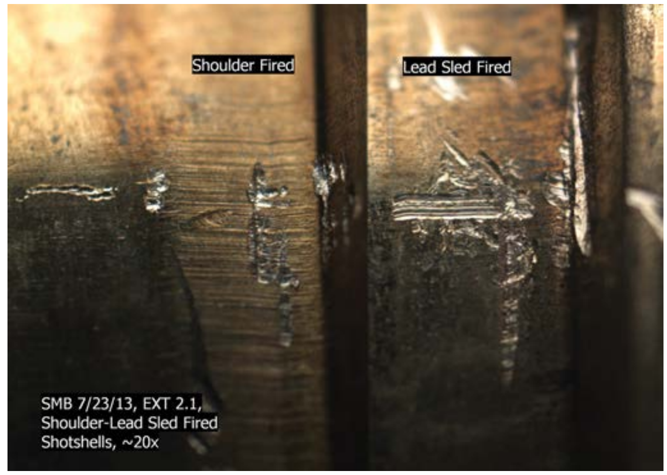

Figure 18: Quality of marks from extractor 2.1, fired from shoulder and fired lead sled (~20x)

Blind Comparison Examination

The blind comparison examination was designed to evaluate the previous results concluded in this study. The unknown shotshell "A" was first compared to all of the cycled extractor marks. The initial observation of this shotshell revealed characteristics that looked similar to the MIM extractor marks due to the striations not having a significant depth variation. Therefore, starting with extractor 1.1A, all of the MIM extractors up to 1.4 were compared to the shotshell "A". An identification was made between extractor 1.4 and unknown shotshell "A" (**Figure 19**).

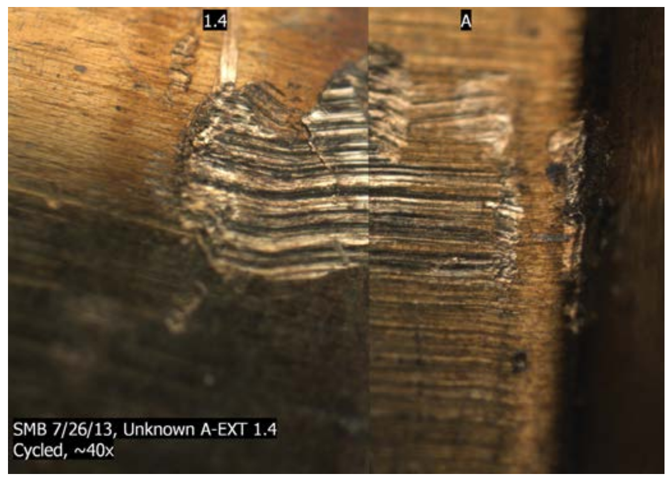

Figure 19: Agreement between marks from extractor 1.4, cycled, and unknown shotshell "A" (~40x)

Initial examinations of unknown shotshells "B" through "F" all exhibited extractor marks with the same characteristic nature which were consistent with being from the MIM extractors. Upon comparison examination with the MIM extractors, all the shotshells were able to be identified as having been cycled by one of the extractors 1.1A through 1.3. The rest of the unknown shotshells (G through L) were all compared to the extractors 2.1 through 2.6 and all were able to be identified back to the extractor that cycled it.

During the comparison of all of the unknown shotshells, it was observed that each extractor mark had a unique characteristic appearance that was traced back to the extractor that produced it. This appearance was replicated in all of the cycled shotshells. 100% of the identifications made during the blind comparisons were correct. This conclusion verifies that all of the extractors, MIM or milled, can be differentiated from one another. MIM extractors generated by the same mold cavity or even by the same mold can be distinguished from one another in cycled shotshells. This also signifies that cycled extractor marks from MIM and milled extractors can be differentiated from one another.

Summary

It was determined that although there was some carryover of striations from extractor to extractor, this had little effect and did not lead to an incorrect identification. The cycled shotshells for both MIM and milled extractors exhibited a higher quality extractor mark than the fired shotshells. The cause is not known, but this may be probative during a forensic firearms examination of cycled versus fired extractor marks. Although the milled fired extractor marks were of a lower quality than the milled cycled extractor marks, they were still suitable for a comparison examination unlike the MIM fired extractor marks.

The comparison between the Lead Sled fired and cycled shotshells from the same milled extractor resulted in an inconclusive result due to a lack of consistent striations and their location on the fired shotshells. However, it should be noted that the shoulder fired shotshells for the MIM extractors were similar to the cycled shotshell extractor marks. Some reasons that could account for the change in extractor marks from the shoulder fired versus being fired in the Lead Sled are the give in the shoulder when fired normally versus the hard recoil pad on the Lead Sled or how the forearm is held.

All of the fired shotshells from each MIM and milled extractor (except extractor 2.5) that were suitable for a comparison examination were able to be identified to their respective extractor. All of the cycled shotshells from each MIM and milled extractor were also able to be identified back to the extractor that produced it (except cycled shotshells from extractor 1.2). Some carryover did exist from extractor to extractor, however, this did not lead to a misidentification between extractors of the MIM or milled type. The blind study demonstrated that each one of the extractor marks in the Remington 870 could be differentiated from one another and that extractor marks generated could be identified back to the extractor that made them. The results of this study support the individuality of the Remington 870 extractors of both the MIM and milled types.

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